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Some characteristics of honeybee *Apis mellifera carnica* (Hymenoptera: Apidae) drones produced from six different Governorates in Egypt

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Abstract

Some characteristics of honeybees (*Apis mellifera* ***carnica***) (Hymenoptera: Apidae) drones produced from some locations in Egypt were studied. For this purpose, drones from six different governorates of Egypt were used: Al Menofia (Ashmon), Al Qalyubia (Shubra Alkemyah), Cairo (Al Mokattam), Al Giza (Dokki), Al Fayoum (Elkabi), and Benisueif (Beba). The drones used in the study were reared in experimental colonies under spring season conditions. The measured parameters were. Drone body weights, both the length and the width of right wings, and the length for each seminal vesicle and mucus gland, as well as the total amount of sperm ($x10^6$). The obtained results indicated that the mean weight of drones from Al Menofia (0.198±0.03 mg) and Benisueif (0.188±0.02 mg) occupied the1st category. Drones of Cairo (0.184±0.02 mg) and Fayoum (0.179±0.02 mg) occupied the 2nd category. The diameters of the right forewings of El Fayoum drones (12.437±0.11 mm for length and 3.949±0.27 mm for width) were higher than those of drones from other areas. The length of right hind wings of Benisueif drones (8.272±0.39 mm) and the width of right hind wings of Al Menofia (3.874±0.01) occupied the 1st rank. Drones of Cairo occupied the 1st rank in each of the average number of spermatozoa in seminal vesicles (7.300±3.09 $x10^6$) and the length of mucus gland (5.267±0.31). Statistical analyses proved that there were significant differences between the values of these two parameters and those of other areas. In conclusion, drones of Cairo represented the most suitable, where they occupied the 1st category in the reproductive organ characteristics and the 2nd category for each of body weight and length of seminal vesicles.

Introduction

The honeybee, *Apis mellifera* L. (Hymenoptera: Apidae) is a significant insect for both the economy and the environment. When discussing with queens and drones. Hatjina *et al*. (2014) found that the term quality refers to specific quantifiable physical and behavioral characteristics. However, it is recognized that the function of the queen and the drones that are associated with her regulate the productivity of the honeybee colony. Rhodes (2002) mentioned that sufficient rearing of healthy drones is the prime step for successful queen mating.

Honeybee queens can mate with an average of 12 drones (range 1-32) and are able to hold 4.3-7.0 million spermatozoa in her spermatheca. Throughout their 55day life span, drones mature within 16 days and become less suitable for mating after 28 days.

According to Laidlaw (1981), drones' fundamental job in the colony is to fertilize virgin queens. Discovering suitable buddies for the virgin queens is one of the most misunderstood aspects of honeybee queen upbringing. Effective queen rearing is limited by the ability to produce viable drones. Drone study results help sustain far-breeding operations by increasing effectiveness (Laidlaw and Page, 1998). Based on experiments of Parsons and Hoffman (Bjorksten *et al*., 2000, and Rantala *et al.*, 2004), a grown-up honeybee drone flies to designated swarm congregate areas (DCAS) in order to mate with virgin queens. Only a small percentage of the drones raised by honeybee colonies are able to conceive with a queen. As a result of this, it is reasonable to assume that adult drones are the target of intense selection during mating flights, and any specific trait observed in drones in these regions may serve as a proxy for the traits that the filtering process is operating on. Wing fluctuation asymmetry (FA) is one of the most relevant morphological traits employed as a stressor is one of the most crucial as a bioindicator to measure developmental instability in many insects.

In Egypt, honeybee races and hybrids are kept under many multiple stress factors (MSF), including the genetic origin of bee races, environmental conditions, diseases and pests, lack of pollen and nectar sources, air pollution, as well as the use of pesticides and Genetically Modified Organisms (GMO). Therefore, the current study was to find out how the presence of honeybee colonies in various environmental settings is affected by specific features of drones made from these apiaries, to investigate the effect of the presence of honeybee colonies under different environmental conditions on some characteristics of drones produced from apiaries of these locations.

Materials and methods

1. Studied locations:

The current investigation was conducted in six apiaries in six different governorates of Egypt: Al Menofia (Ashmon), Al Qalyubia (Shubra Alkemyah), Cairo (Al Mokattam), Al Giza (Dokki), Al Fayoum (Elkobi), and Benisueif (Beba) (Figure 1), during spring 2024 to study the effect of the environmental conditions of these locations on some characteristics of the honeybee, *Apis mellifera carnica*, drones reared in these locations. The investigation of the drone's morphometric and reproductive organ characteristics was carried out at the laboratory of the plant protection institute.

2. Employed colonies:

A total of 18 colonies of *A. mellifera carnica* (3 colonies from each apiary) were used for this study. A total of 180 mature drones were used.

3. Drone samples:

Mature drones of unknown age:

A total of 180 mature drones were used; only those with shrunken testes and yellowish or greenish were considered as mature drones (Dade, 1962). Samples were taken during the early morning to ensure that the drones were found in their hives.

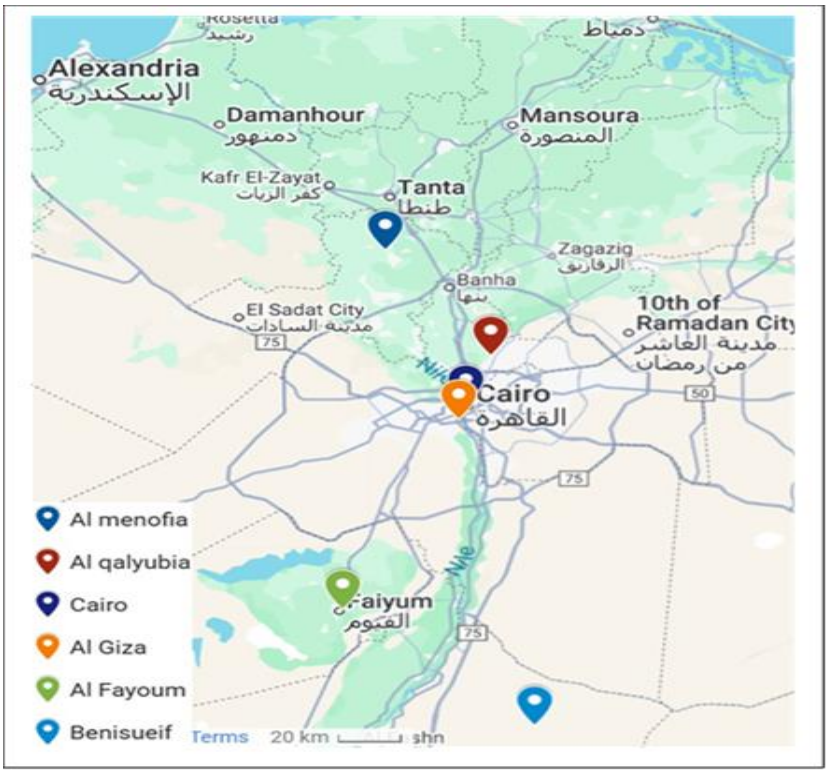

Figure (1): Map of drone samples in the six geographical areas of Al Menofia, Al Qalyubia, Cairo, Al Giza, Al Fayoum, and Benisueif Governorates, Egypt.

4. Drone measurements:

4.1. The morphometric characters:

4.1.1. Drone body weights: The tested drones were individually weighed using an electrical balance.

4.1.2. Wing measurements:

For this purpose, about 30 drones from each apiary from each region were used, where both right wings of each drone were taken. The samples were stored in 96% alcohol until the time of the preparation of slides. Slides were prepared and then placed into the incubator (40°C) for 48 hrs. to dry completely. After that, photos were taken of each sample by using a dissecting binocular microscope supplied with a program called EP. View. The measurements of all lengths and widths of wings were measured with the help of the Compu Eye LSA program (Bakr, 2005).

4.2. The reproductive organs characters:

4.2.1. Sperm number:

The sperm number was counted by dissecting the seminal vesicles of the drones. (Moritz, 1981). The number of sperm was determined using an improved Neubauer hemocytometer (Hafez and Hafez, 2000).

4.2.2. Seminal vesicles and mucus gland measurements:

Seminal vesicle and mucus gland measurements were carried out by using a dissecting binocular microscope fitted with an ocular micrometer. The measurements of all lengths were measured with the help of the Compu Eye LSA program (Bakr, 2005).

5. Statistical analysis:

Data obtained were analyzed using one-way ANOVA, and the least significant difference (LSD) was determined at P=0.05. Cohort Software was used for statistical analysis (CoHort Software, 2004).

Results and discussion

1. Morphological characteristics:

Data in Table (1) indicate that the mean weight of drones from Al Menofia

(0.198±0.03 mg) and Benisueif (0.188±0.02 mg) occupied the 1st category. Drones of Cairo (0.184 ±0.02 mg) and Al Fayoum (0.179±0.02 mg) occupied the 2nd category. Drones of Al Giza (0.156±0.02 mg) and Al Qalyubia (0.147±0.01 mg) occupied the last category, without significant differences between the values of each category. The diameters of the right forewings of Al Fayoum drones (12.437±0.11 mm for length and 3.949±0.27 mm for width) were higher than those of drones from other areas. Statistical analyses proved that there were no significant differences between the values of El Fayoum and other areas, except that of Al Qalyubia. The length of the right hind wing of Benisueif drones (8.272±0.39 mm) and the width of the right hind wing of Al Menofia (3.874±0.01) occupied the 1st rank, with significant differences between them and the values of other areas. Kenmogne and Romuald (2018) showed that honeybee drones had an average weight of 202.81±17.84 mg at maturity, a wing length of 12.40±0.66 mm, and a wing width of 3.83±0.30 mm.

Table (1): Body weights and right-wing dimensions for different types of drones in different areas, as well as statistical analyses.

Origins Drone	Body weight (mg)	wing dimensions Right			
		Forewing (mm)		Hindwing (mm)	
		Length	width	Length	Width
Al Menofia (Ashmon)	0.198±0.03^{a}	12.283±0.03^{ab}	3.694± 0.44^{ab}	7.629±0.01^{bc}	3.874±0.01^{a}
Al Qalyubia (Shubra Alkemyah)	0.147± 0.01^{c}	11.866±0.39^{ab}	3.793 ±0.05^{ab}	7.524±0.27^{bc}	3.122 ± 0.27^{c}
Cairo (Al Mokattam)	0.184 ±0.02^{b}	12.122± 0.10^{ab}	3.604±0.06^{ab}	7.445± 0.38^{bc}	3.310± 0.38^{c}
Al Giza (Dokki)	0.156± 0.02^{c}	11.830±0.68^{b}	3.515±0.02^{b}	7.296 ±0.04^{c}	3.362 ±0.04^{bc}
Al Fayoum (Elkabi)	0.179± 0.02^{b}	12.437± 0.11^{a}	3.949±0.27^{a}	7.815±0.02^{b}	3.594± 0.02^{b}
Benisueif (Beba)	0.188± 0.02^{ab}	12.367 ±0.11^{ab}	3.639±0.055^{ab}	8.272±0.39^{a}	3.270±0.39^{c}
LSD	**0.17**	**0.58**	**0.38**	**0.44**	**0.263**
F	**10.62**	**1.48**	**1.55**	**5.81**	**9.98**
P.	**0.000 ****	**0.18 ns**	**0.25ns**	**0.006***	**0.006***

2. Reproductive organs characteristics:

Data in Table (2) indicated that drones of Cairo occupied the 1st rank in each of the mean number of spermatozoa in seminal vesicles (7.300±3.09 x10^{6}) and the length of the mucus gland (5.267±0.31). Statistical analyses indicated that there were significant differences between the values of these two parameters and those of other areas. For the length of seminal vesicles, drones of Al Fayoum (3.212±0.39) occupied the 1st rank, while those of Cairo (3.13±0.33mm). Occupied the 2nd rank without significant differences. From the above results, it could be concluded that the drones of Cairo represent the most suitable, where they occupied the 1st category in the reproductive organs characteristics and the 2nd category for the weight of the body. As stated by Kenmogne and Romuald (2018) honeybee drones had an average weight of 202.81±17.84 mg at maturity. The average area of the seminal vesicle was 8.60± 2.92 mm^2, and the average volume of the mucus gland was 25.45±8.59 mm^2. The number of spermatozoa was determined by Rinderer *et al.,* 1999; Schlüns *et al*. ,2003 and Gencer and Firatli, 2005, by analyzing the seminal

vesicles of drones aged 11 or 12 days. The sperm numbers in each drone ranged from 1 to 30 million, with an average of (7.6 to 12.0 million sperm on average across the various studies according to Salem (2017), showed that, the mean weight of drones reared in El-Mokattum was (185.72 mg) while the weight of drones reared from Dokki was (180.40 mg), whereas the mean number of sperms was insignificantly higher for El-Mokattum ($7.490x10^6$) than those of Al-Dokki ($6.375x10^6$). Rhodes *et al.* (2011) and Czekonska *et al.* (2013), the amount of sperm generated per drone may vary depending on, age, season, genetics, and disease. Mazeed and Mohanny (2010) recorded that, the number of spermatozoa ($4.63x10^6$±3.89), length of mucus gland (4.06±0.47 mm) and weights of drones (180±7.07mg) were estimated in free honeybee matured carniolan drones, body mass (mg) 143.7±2.9, sperm count ($x10^6$) 10.50±0.68, seminal vesicle length (mm) 3.21±0.04, mucus gland length (mm) 3.91± 0.05.

Table (2): The length of the reproductive organs (mucus gland and seminal vesicles) and the number of sperm ($x10^6$) and matured drones from various regions. Additionally, statistical analysis.

Drones from	No. of sperms ($x10^6$)	Length of reproductive organs	
		Seminal vesicles	Mucus gland
Al Menofia (Ashmon)	5.978±1.85^b	2.897± 0.43^{abc}	4.123± 0.34^b
Al Qalyubia (Shubra Alkemyah)	0.380.500±0.55^c	2.765±0.28 ^{c}	3.377±0.30^d
Cairo (Al Mokattam)	7.300±3.09^a	3.13± 0.33^{ab}	5.267±0.31^a
Al Giza (Dokki)	0.996.250± 0.77^c	2.626±0.29^c	3.486±0.37^d
Al Fayoum (Elkabi)	5.659± 2.40^b	3.212±0.39^a	3.821±0.22^c
Benisueif (Beba)	4.978± 2.19^b	2.842±0.39^{bc}	4.143±0.32^b
p.	**0.000*** **	**0.005***	**0.000***
LSD	**1.81**	**0.32**	**0.28**
F	**28.74**	**3.84**	**47.27**

Industry and academics have focused heavily on the high percentage of annual colony losses, queen health, and fecundity. However, a large portion of the queen's reproductive quality depends on how well the male mates. The current study was conducted to examine the impact of honeybee colonies in Egypt under various environmental conditions on certain drone production features. Six different Governorates of Egypt were used in this research, the obtained results indicated that the drones of Cairo (Al Mokattam) represented the most suitable, where they occupied the 1st category in the reproductive organ characteristics and the 2nd category for each of body weight and length of seminal vesicles. This finding highlights the importance of choosing a site for inseminating queens, which deserves more future studies.

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